The ^{210}Po Poisoning Incident in London, November 2006 – the work of the HPA radiochemistry team

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Main events: monitoring of people (1)

Dates	Events
1/11/06	Presumed date of poisoning
3/11/06	Admission of Litvinenko as a patient at Barnet General Hospital (North London), [and subsequently transferred to University College Hospital (UCH) (Central London)]
22/11/06	CRCE Director informed of possibility of ^{210}Po poisoning Specialist RPD team assembled **Information on background levels of ^{210}Po in the body and excreta collected**
23/11/06	RPD Core Team assembled ***Consideration given to levels of ^{210}Po in the body that could give rise to observed symptoms***

Main events: monitoring of people (2)

Dates	Events
23/11/06	Realisation that contamination of Health Care staff could be an issue
23/11/06	HPA informed that presence of ^{210}Po in Mr Litvinenko confirmed
23/11/06	Mr Litvinenko dies at UCH
24/11/06	Pine Bar at Millenium Hotel and Itsu Sushi Bar closed to the public
24/11/06	Full HPA emergency response
24/11/06	Consideration given to the bioassay monitoring necessary for the assessment of internal doses for Health Care staff and members of the public

Main events: monitoring of people (3)

Dates	Events
24/11/06	Consideration given to - HPA measurement capacity for urine samples (~ 20 per day) & measurement time (48-72 h) - Minimum detectable activity, and resulting minimum detectable dose - other UK laboratories that could assist with ^{210}Po-in-urine measurements
24/11/06	Documents developed : - Sample collection instructions for people providing samples - Information leaflet - Triage questionnaires for Health Care staff and others
24/11/06	**Urine sampling programme initiated**
26/11/06	**First urine samples received**

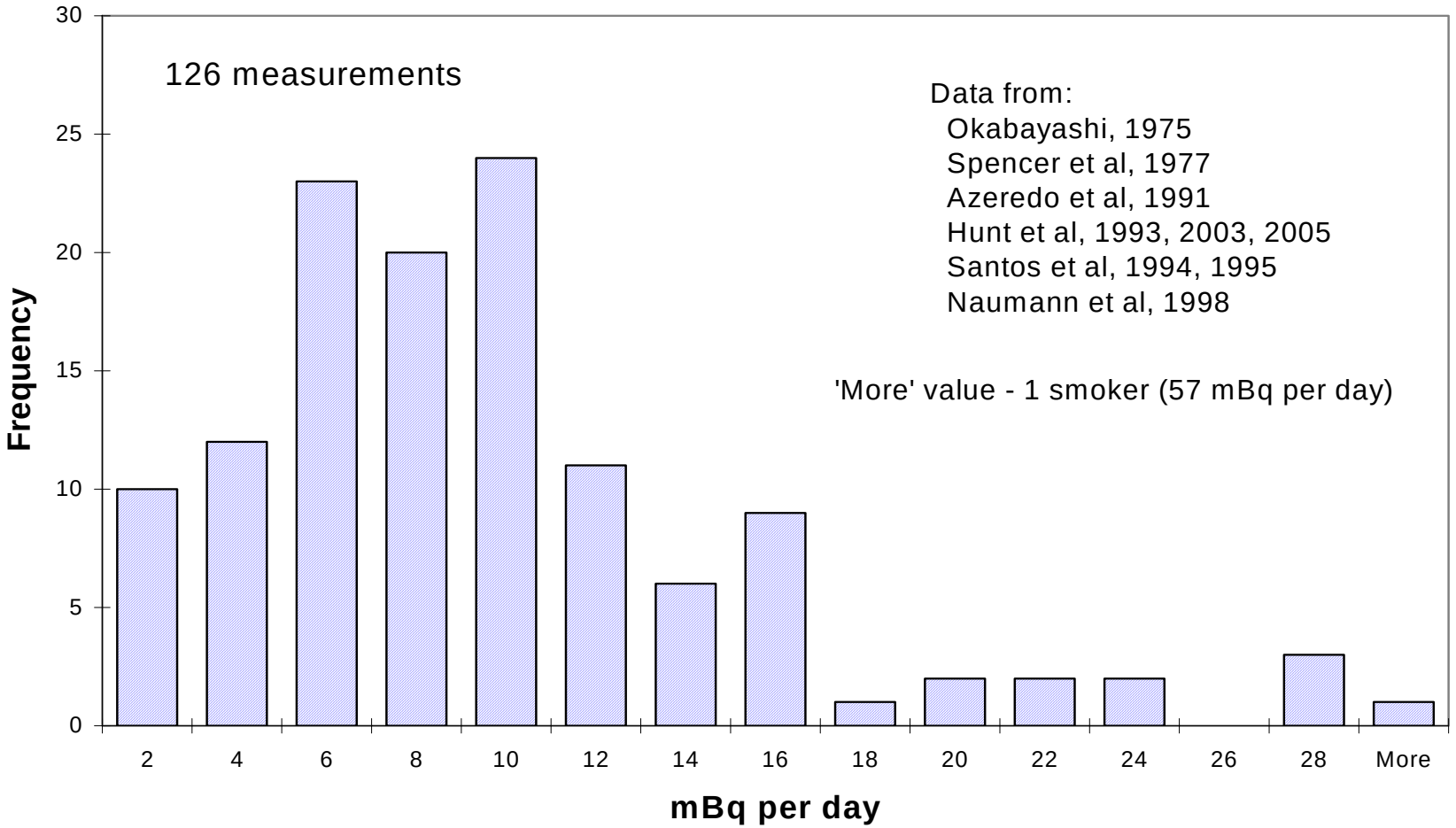
Bioassay Monitoring Programme

Relative merits of urine and faecal sampling

Urine	Faecal
Easier to obtain samples from people	
Sample containment is easier	
Fewer practical problems with laboratory sample handling	
Dose assessment uncertainties are generally lower (e.g. lower day-to-day variation in excretion rate)	
	Somewhat higher sensitivity (Faecal excretion rate ~ 2-3 x urine excretion rate)

---> Decision was rapidly made to collect 24 hour urine samples

Reported Natural Levels of ^{210}Po in Urine



Detection Limits

Initial estimate of DL = 20 mBq per day

In practice, DLs were lower, typically in the range 1 - 10 mBq per day

A Reporting Level (RL) of 30 mBq per day was chosen

This RL corresponds to a minimum detectable dose E(50) ~ 0.3 mSv (20 days after intake) based on the cautious assumption of 100% intake by inhalation.

Excretion in urine decreases with time following intake. Thus, the dose assessed from 30 mBq per day increases with time after intake: e.g. 1 mSv at ~100 days (mid-February 2007)

Urine Analysis

- Existing method for environmental samples adapted for urine.
- Method adapted for quicker turn-round with higher LOD's.
- Validation
  - Initially blank urine from staff.
  - Later exchange of check samples with other laboratories.
- QA Considerations
  - Outside UKAS schedule.
  - But use similar QA procedures.

Polonium-210 in urine - the analytical procedure

- Upon receipt, record sample details
- Add ^{209}Po tracer to 1 litre of urine
- Digest carefully with concentrated nitric acid and evaporate overnight
- Take up in hydrochloric acid and deposit onto a silver disc
- Measure activity of ^{209}Po and ^{210}Po using alpha spectrometry, counting overnight

Even under most favourable conditions, data could not be produced until at least 2 days after the sample had been received.

Individual Monitoring Strategy

Direct assessment of exposure of individuals feasible through measurement of ^{210}Po in urine.

Potentially large numbers.

- Initially, staff at two hospitals, sushi bar, friends and family - a few tens.
- Rapidly expanded to hundreds with additional locations.

Strategy: obtain samples from those with highest potential for exposure, being in a particular location at a particular time. Provides important information on:

- Whether or not the individual who gave sample had an intake of concern for health effects
- Potential exposure of other people in similar situations

Provides reassurance to people with lower potential for exposure (typically at the same place, but later)

From Triage to Reporting

- HPA Local and Regional Services (LARS), developed triage procedures to identify those with highest potential for exposure
- LARS requested urine samples from identified individuals and arranged collection
- Radiation Protection Division (RPD) at Chilton measured activity in samples, assessed doses and reported results to LARS
- LARS communicated results to individuals: putting them in perspective.

Triage questionnaires (1)

Health Care staff

Some of the questions asked:

1. Were you involved in the care of the patient ?
2. Did you come into direct contact with urine, faeces, vomit, blood, or other body fluids ?
3. Were there occasions when you did not wear the standard personal protective equipment for the work you undertook ?
4. Were there occasions when you did not follow the prescribed hygiene rules ?

Answers determined whether urine samples were requested. All those answering YES to Q2 were asked to provide a urine sample.

Triage questionnaires (2)

Hotel staff

Some of the questions asked:

1. Did you work in the hotel on any day between aa/bb/2006 and xx/yy/2006 ?
2. Did you work in any of the following rooms (Room AA, Room BB, Room CC) ? If YES, what did you do ? (Carrying bags, cleaning bathooms and toilets, etc.)
3. Did you work in the Hotel Bar ?
4. Have you been ill ? If YES, have you had any of the following:

   Nausea, vomiting, diarrhoea, fever, sore throat, bleeding gums, unusual bleeding from cuts

Answers determined whether urine samples were requested (e.g. those working in the Hotel Bar during a defined period were selected).

All those reporting any of the underlined symptoms were also selected.

Practicalities of urine sampling for large numbers of people

Main Issues

- Availability of urine sample bottles in sufficient quantities
- The need for clear instructions on how to provide 24 hour samples (for people whose first language may not be English)
- Organisation of transport arrangements at short notice
- Laboratory sample throughput and analysis time – potentially many hundreds of samples could require analysis
- The need for assistance from other UK laboratories with sample measurements
- The provision for international assistance with sample measurements if needed
- Disposal of urine samples

Cross-check sample results -

Measured ^{210}Po in urine (mBq l^{-1})

Collaborating Laboratories

HPA	23 ± 7	17 ± 6	44 ± 12
Lab	29 ± 13	16 ± 3	46 ± 12

Others

HPA	12 ± 4	197 ± 30	13 ± 4	193 ± 23	60 ± 10	48 ± 8
Lab	18 ± 5	174 ± 10	16 ± 7	146 ± 9	80 ± 8	66 ± 9

HPA	242 ± 32	242 ± 32	76 ± 15	36 ± 6	45 ± 8
Lab	195 ± 11	190 ± 15	58 ± 5	38 ± 6	58 ± 12

All results corrected for decay

Laboratory issues

Equipment – new hotplate stirrers, freezers

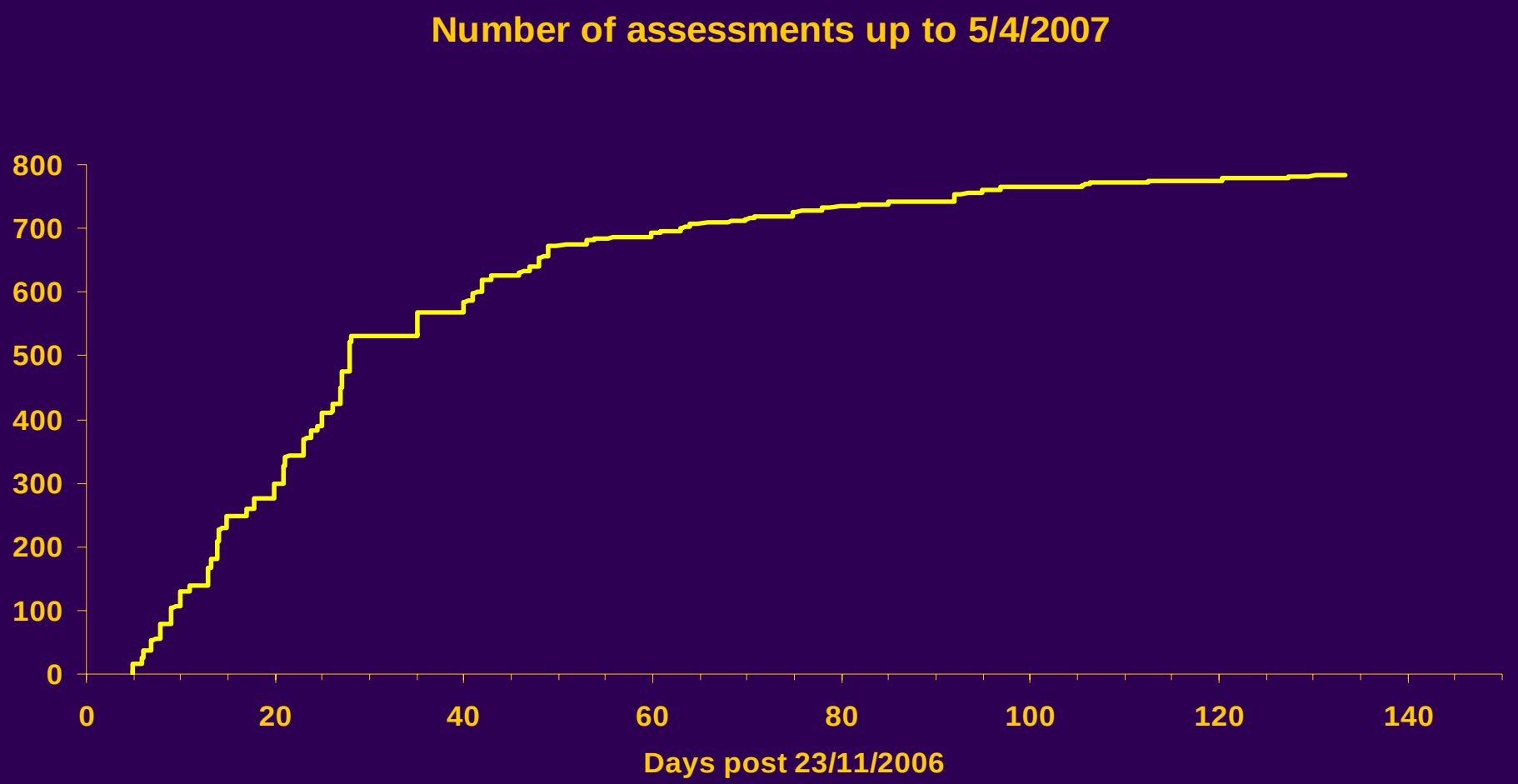
Consumables – glassware, chemicals, plastic bottles, transport boxes

Laboratories – rearranged, decks cleared

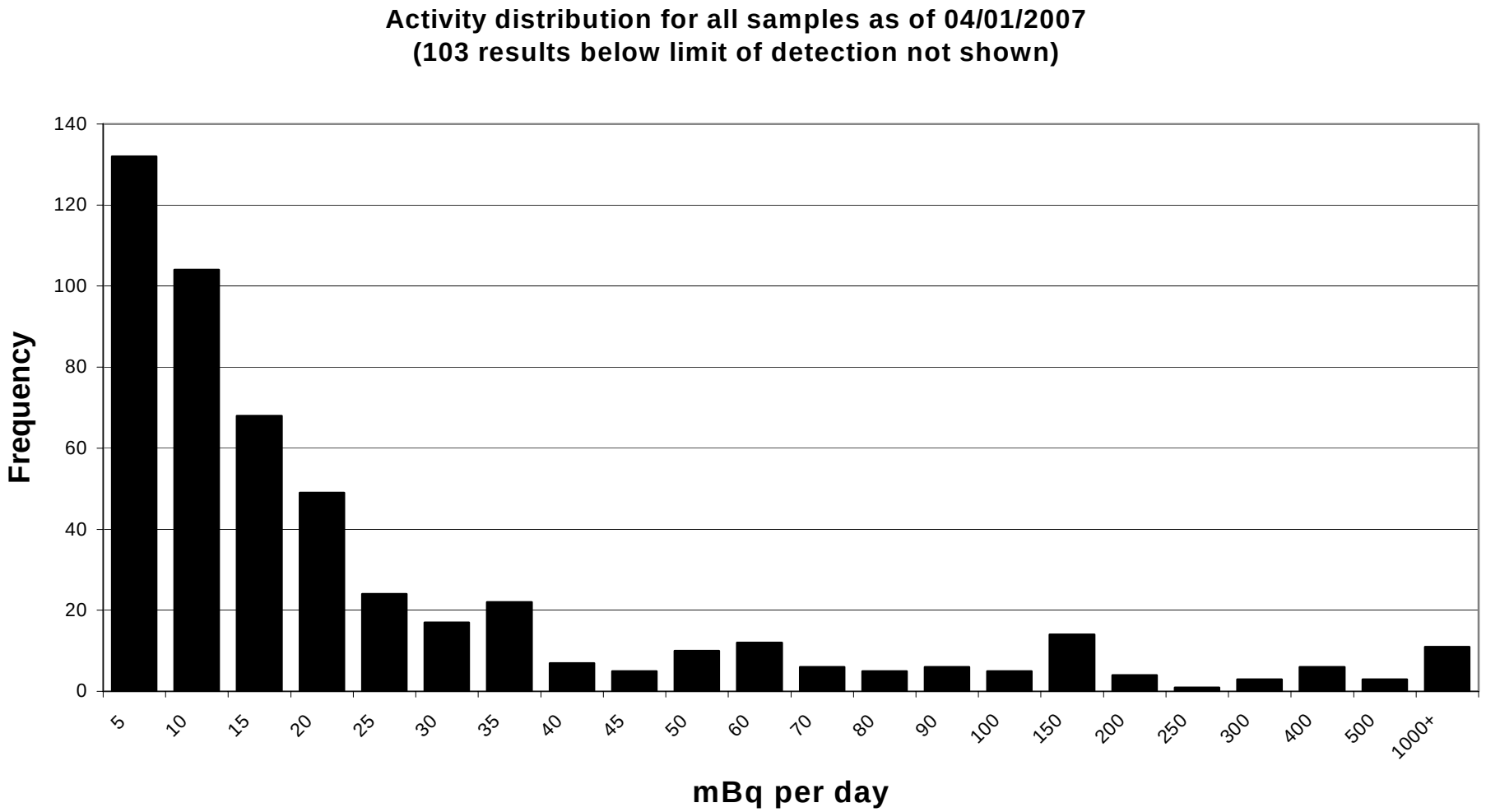
Staff – adequate cover to maintain throughput, weekends and late nights, important to build in sufficient time off

QA and Throughput - Important Factors in Bioassay

Throughput of Samples & Dose Assessments



Results of the Urine Monitoring Programme



Individual Monitoring & Dose Assessment: Summary

- Biokinetics and practical considerations identified urine as favoured means of assessing doses
- Existing capabilities and experience rapidly adapted to unforeseen situation
- Urine monitoring system for hundreds of samples per week: collection, analysis, assessment and reporting, set up within a few days
- Support from other laboratories; consistency assured using check samples
- International collaboration: reserve capacity, information exchange
- Combined resources of HPA: not only RPD and LARS but also other Divisions, enabled an effective response to be made to an extraordinary event

General observations

Pre-existing accreditation to ISO standards (17025/9001:2000) but outside of our schedule.

However:

- QA issues addressed
- Fewer mistakes
- Better planning

Collaboration – communication

- No backlog of samples at any time.
- Justification for participation in national, international projects, intercomparisons, workshops, meetings etc.

A typical day !